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Scanty Regeneration of Baobab (*Adansonia digitata*) in West Kordofan State, Sudan

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Abstract

The *Adansonia digitata* (L.) locally known as the *Baobab* or *Tebaldi* tree is an important multi-purpose species in the dry lands of the Sudan. It has been underutilized, inaccessible and neglected from many potential applications and uses in the country. Being one of the species producing countries, Sudan incorporates the *Baobab* under different land use patterns and locations such as agricultural lands, outcrops, grazing lands, villages and homes. The current study was conducted in two years 2014 and 2015, with special focus on the factors that influence the regeneration of the *Baobab* in two sites namely *Elkhoway* and *Eldudia* in West Kordofan State. The two areas were intentionally selected as they are accessible and typical example of sites highly populated with the *Baobab*. Primary data were collected from systematically located twenty strip sample plots each was 1 Km long and 50 m wide. In each sample plot all *Baobab* trees, saplings and seedlings were counted and measured for diameter at breast height. Secondary data were obtained from relevant sources, references and pertinent institutions. Data were analyzed using R statistics software as well as Statistical Packages for Social Sciences (SPSS), where descriptive analysis was applied. The average diameter at breast height of *Baobab* tree was measured as 214.1 cm and 236.3 cm for *Eldudia* and *Elkhoway,* respectively. The two sites were significantly different ($p \leq 5$) with respect to minimum diameter at breast height, which was found as 57.3 cm for *Eldudia* and 114.6 cm in case of *Elkhoway* site. The main findings revealed that past recurrent drought spells, wind and climate change had negative impacts on population density of the *Baobab* in the study area. Human practices and overgrazing were considered as the most affecting factors having adverse impacts on regeneration of the *Baobab*. Overgrazing, frequent floods and consequential erosions were the top listed factors threatening *Baobab* regeneration. It was concluded that the *Baobab* regeneration in West Kordofan State has been negatively affected, which case necessitated urgent intervention. The study recommended development of strategies that enable interventions aspiring at achieving proper management, conservation and rehabilitation as well as successful regeneration of the *Baobab* populations in the area.

Keywords

Baobab, Tebaldi, Regeneration, Climate Change, Conservation, Overgrazing, West Kordofan

1. Introduction

Sudan covers an area of 1,882,000 square kilometers. It is located in the northeastern part of Africa between latitudes 8° - 22°N and longitudes 22° - 38°E (USAID, 2012). The vast longitudinal extension gives the Sudan unique ecological characters, from dry sandy desert in the northern central parts to high rainfall areas in the south (Sudanet, 2015). The forest cover was estimated as 11.60% of the total country area, while agricultural lands, range and water constitute 13.70%, 26.40%, and 0.17%, respectively USAID (2012). The most important forest types in the Sudan include *Acacia nilotica*, *Acacia seyal*, *Acacia senegal*, *Balanites aegyptiaca*, *Acacia mellifera* and special forest types like *Hyphaene thebaieca*, *Tamarix aphylla*, and montane forests (Harrison & Jackson, 1958; Sahni, 1968; Geller *et al.*, 2009). The Baobab (*Adansonia digitata*) populations have been received special consideration among the most important tree species in Sudan since ancient times (Sahni, 1968). The Baobab tree is a multi-purpose species; is has been ranked among the most intriguing vegetable on the earth and each part of it has a use. Nowadays the Baobab products are recognized at all levels; locally, regionally and at international level, it is well-known and much more famous in the European markets rather than in eminent producing African countries. In recent years, there has been a lot of concern about the populations of Non- Timber Forest Products (NTFPs). The declining production trend of the tree species providing NTFPs could be attributed to land-use intensification and over-harvesting. Consequently sustainable use and appropriate management of such species are urgently needed (Obiri *et al.*, 2002; Djossa *et al.*, 2008). Sudan is indicating valuable germplasm and great potential for domestication of NTFPs, which implies further investigations (Gebauer and Luedeling 2013). The Baobab populations in Greater Kordofan could serve as interesting study objects for evaluating dynamics of baobab populations (Gebauer and Luedeling 2013).

According to Darr *et al.* (2014), very limited information is available on Baobab populations existing in Kenya and Sudan. In Kenya for example, the baobab trees were found on 50% of 104 farms surveyed in a semi-arid area of Eastern Kenya (Kehlenbeck *et al.*, 2013; Darr *et al.*, 2014).

Being conducted in sites densely populated with Baobab trees, the current study focused on investigating factors that might have been thought to be the main causes of poor or even the entire absence of Baobab regeneration in the last decades. As well, the study dealt with measures necessary for ensuring conservation of possible new regeneration in an attempt to keep on the sustainability of utilization.

2. Study Rationale and Justification

Throughout its distribution area in Africa many observers have commented on the lack of natural recruitment of *Adansonia digitata*. However, because of its longevity, only a low rate of recruitment is required to maintain populations (source). In the drier areas, such as the Sahel zone and Botswana, natural regeneration occurs in exceptionally wet years and the seedlings require either ground water or at least 350 mm annual rainfall to survive. Even in South Africa, with an annual rainfall of 400–500 mm, it has been estimated that regeneration only occurs once every 100–150 years. Increasing human and livestock populations, expanding cultivation and deforestation have further exacerbated the effects of climatic change (Wickens and Lowe, 2008). Some of the observers who have commented on the absence or limited baobab natural regeneration in Africa might have failed to recognize the species saplings with their slender stems and simple tender leaves. Based on records of relevant institutions and personal observations of the authors, the natural regeneration of the baobab could hardly be reported in Sudan except in the Nuba Mountains (rainfall 700–800 mm), where only saplings have been seen on the hillsides of the Nuba Mountains. Wickens (1982) attributed the exceptional successfulness of the phenomenon to the higher rainfall intensities although it was suspected that protection from fire might be an important factor too. It might well be thought that elsewhere the seedlings and saplings of the baobab species succumbed to fire and grazing. Many of the older baobab trees in the northern Sahel grew up in an environment that was far wetter than in the 20th century. Regeneration was difficult enough during the early part of the last century and became impossible after the Great Drought of the late 1960s with the ensuing desertification. Many mature Baobab trees in the drier parts of the Sudan died during and following the drought. Future climatic deterioration will doubtless take an even greater toll (Wickens and Lowe, 2008). The absence of natural regeneration nowadays has even led some Africans to believe that the baobab is the result of spontaneous generation and appeared by magic overnight (Wickens and Lowe, 2008), others believe that the trees possess souls or are inhabited by ancestral spirits. Some even believe that the trees walk about at night but have to stay in one place during the day (Sweeney 1973). As stated by Davies (1957), there was no indication of natural regeneration of *Baobab* population in West Kordofan and even the oldest inhabitants have never seen a Tebaldi tree looking any younger than it does now. Some forest inspectors assumed that the *Hamar* goats are the main influencing factor responsible for the absence of Baobab regeneration in *Dar Hamar*, West Sudan (Parr, 1924). The same researcher stated that he had never seen during his work in Ennuhud more than two fallen Baobab trees as a result of strong winds in autumn in the year 1922, although the species is characterized by having a shallow root system. However, on the contrary half population of *Balanites aegyptiaca* and other indigenous trees were reported to fall down (Elhaj, 2014).

As stated by ElTahir (1999), most of the native fruit trees and medicinal plants (including the Baobab) in Sudan exist within natural forests, woodlands, farming fields and home gardens. No resource base assessment has been conducted; therefore there is high need to conduct research and studies oriented to important aspects of such species with special emphasis to tree distribution and regeneration, tree population structure and dynamics, as well as species utilization and sustainability. For providing assistance in estimating present and future production potential for different regions, Darr *et al.* (2014) recommended development of resource map that would show distribution, densities and age structures of the Baobab trees for Kenya and Sudan. Nevertheless, domestication, which includes selection of superior mother trees, their vegetative propagation and cultivation on farms, was also recommended (Buchmann *et al.,* 2010).

3. Materials and Methods

3.1. The Study Site Description

West Kordofan State is located within latitudes 27°-29°N, and longitudes 14°-20°E. The state borders North Kordofan, South Kordofan, East Darfur, North Darfur and South Darfur (Figure 1). Its area is 14400 square kilometers extending from low rainfall savanna to high rainfall and hill catena and its vegetation varies greatly (Alshareef, 1994; IFAD, 2003; LGC, 2015). The climate of the state was thoroughly described by James (1982) and IFAD (2003). The northern part is dry with an average rainfall of 300mm per annum. The far most southern part of the state is characterised with high annual rainfall up to 400mm on the average and high vegetation density. As has been reported by Hunting Technical Services in 1963, the state comprises a number of soil types, the two major and most extensive types being the sandy (qoz) soils (70% of arable lands) in the northern part and the clay soils (30% of arable lands) dominating in the southern part. The variation of climatic zones and different soil types is reflected in the main economic activities of the inhabitants in the study area, which are based on integration of agriculture and animal production (IFAD, 2002; Mahmoud, 2004; Taha, 2006). As in other parts of the Sudanese Gum Arabic Belt, gum arabic from *Acacia senegal* is a predominant component of the customarily practiced subsistence household farm system in the study area (IIES/IES, 1990; Mahmoud, 2004; Taha, 2006; Ramly, 2012). The differences in historical development between traditional farming systems in West Kordofan have been recognized (UNDEP, 2003; Mahmoud, 2004; Taha, 2006; Hammad, 2010). In most rural parts and villages of the area, the main economic activity of people includes crop farming, animal keeping, gum tapping, casual labours, craft men, and others.

Fig. (1). *Location of the study site.*

Davies (1957) described the Baobab environment in Kordofan as being relatively interesting scenery. It was undulating landscape with a surface of red sand carrying thick yellow grasses and *Acacia* forests that yield gum arabic. Rocky Mountains appeared to the south; and every now and then, in some clayey depressions or on the edges of dried-up watercourses, there was an immense Baobab tree, which traditionally provides material (from the bark) for local rope industry and medicine from its fruits. In many parts suffering water shortage in West Kordofan, the Baobab trees were hollowed out and used as water reservoirs.

3.2. Study Methodology

The current study was conducted two times partly late 2014 and then early 2015 in two sites namely *Elkhoway* and *Eldudia* in West Kordofan State. The two areas were intentionally selected as they are accessible and exemplify sites highly populated with the *Baobab* population. Secondary data were obtained from relevant sources, references and pertinent institutions. Primary data were collected from systematically located twenty strip sample plots (strip transects) each was 1 Km long and 50 m wide. In each sample plot all *Baobab* trees, saplings and seedlings were considered, counted and measured for diameter at breast height, total height and their coordinates were reported. Personal observations and additional remarks regarding the associated tree species and land use types were considered. In addition to the ecological data, focus group discussion and personal interviews were also undertaken to obtain information pertinent to the main factors influencing the production system and in turn causing decrease and degradation of the Baobab population, besides the importance of such tree species from viewpoints of respondents.

The diameter at breast height (DBH) recorded for each Baobab tree was used as a main variable in data analysis. However, the mean tree girth was estimated purposively for comparison with similar analysis and findings reached by Edkins *et al.* (2007) in the Kruger National Park.

Both R-statistic software (32-bit) and Statistical Packages for Social Sciences (SPSS V 18) were used for data analysis. Descriptive statistics was done and results were presented in suitable diagrams.

4. Results and Discussion

4.1. Size Class Distribution

Figure 2 is a typical illustration of the current situation of the Baobab trees in the study area. The results of R statistics showed significant differences ($p \leq 5$) between the two sites with respect to the minimum DBH. Since long time in the past, the DBH has been used as the principal variable in studies dealing with the demographic structure of tree species. The distribution of tree species in classes depending on the age as main variable is not reliable, particularly in case of tree species having long live spans such as the Baobabs. The minimum DBH was found as 57.3, 114.6 and 57.32 cm in *Eldudia*, *Elkhoway* and the whole experiment (two sites), respectively. Such findings indicated that only mature Baobab trees were found and no regeneration could be recorded or observed. In case of *Eldudia* all size classes were there, however in *Elkhoway* some size classes were missing. The absence of Baobab trees having DBH lower than 50 cm (which is considered a tree) is really critical. The situation was observed to be much worse in case of *Elkhoway* where the minimum DBH of the Baobab tree was 114.60 cm.

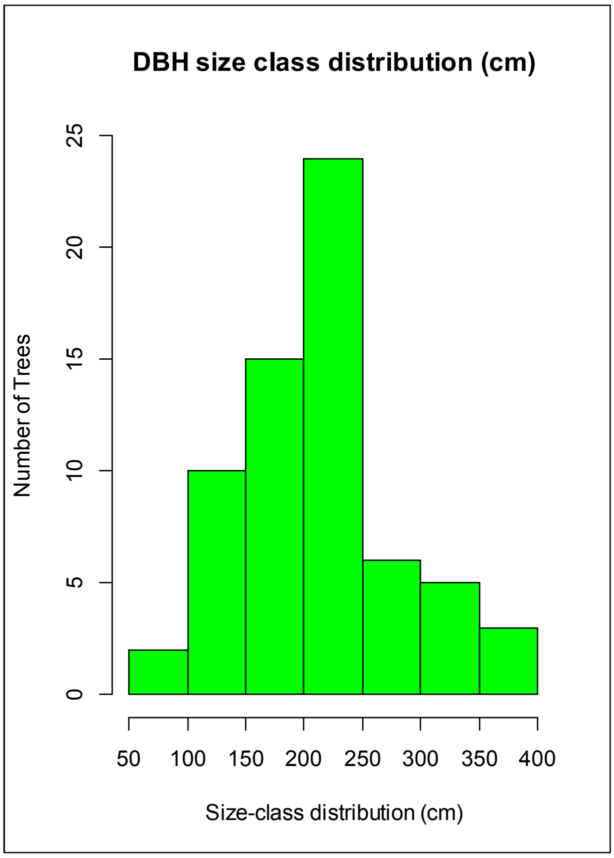

Fig.2 (a). *Eldudia site.*

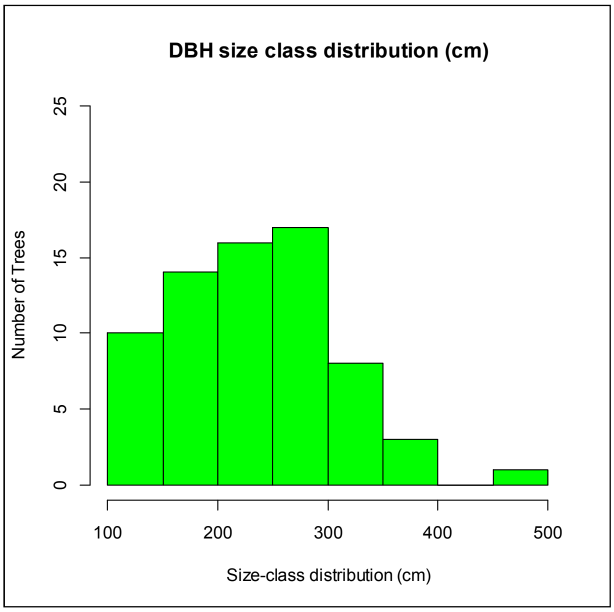

Fig. 2 (b). *Elkhoway site.*

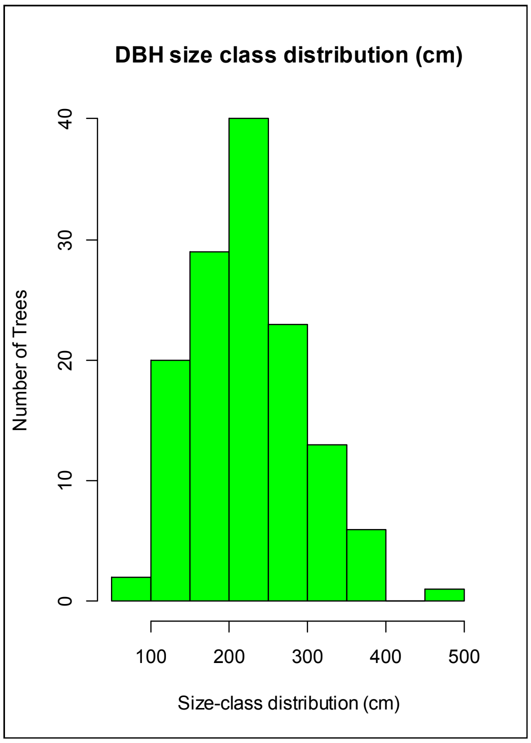

Fig.2 (c). *Both sites together (whole study site).*

Fig. (2). *Size class distribution of diameters at breast height (DBH).*

In Figure 3, the mean, median, upper quartile, lower quartile and the comparison between the two sites have been tested. The average diameter of Baobab trees was found to be 214.10 cm, 236.3 and 255.60 for *Eldudia*, *Elkhoway*and the whole experiment (two sites), respectively.

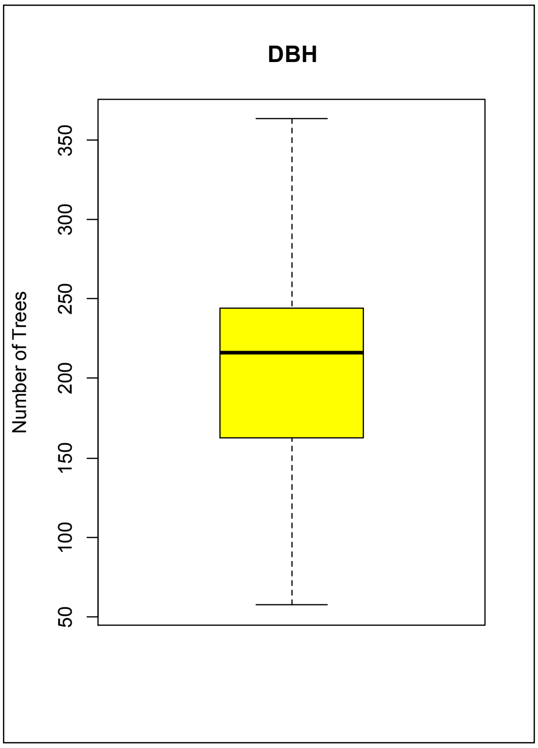

Fig. 3(a). *Eldudia site.*

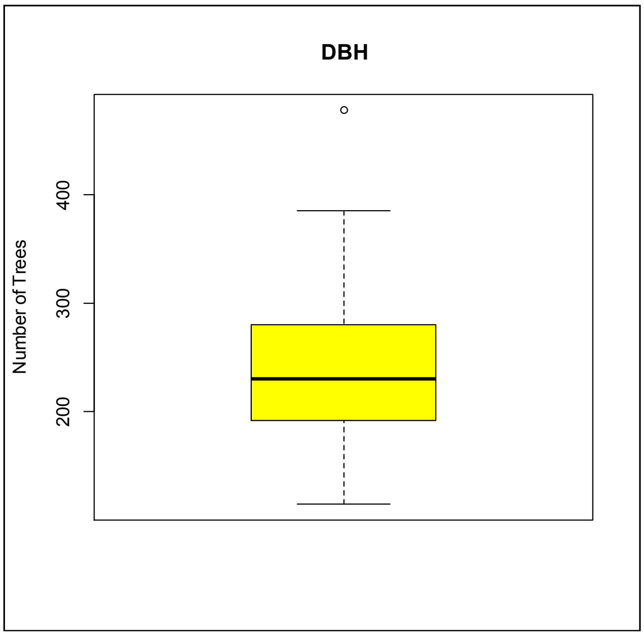

Fig. 3(b). *Elkhoway site.*

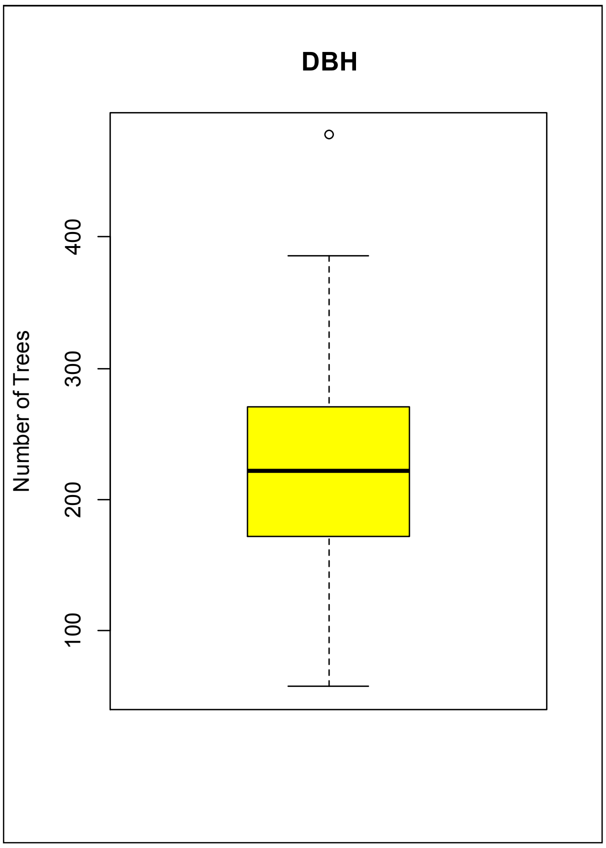

Fig. 3(c). *Both sites together (whole study site).*

Fig. (3). *Box plots of Baobab diameter at breast height (DBH).*

The average DBH was obviously higher in *Elkhoway* compared to the figure estimated for *Eldudia* (Figure 3), this could be attributed to the intensive brick making industry in *Elkhoway,* which has in turn led to removing many Baobab trees. It was also thought that the frequent movement and existence of livestock in large numbers crowded in the premises of *Elkhoway* area could possibly be another cause resulting in widely scattered Baobab trees in relatively large open areas.

4.2. Factors Affecting Development of the Baobab Population

As has been emphasized by the majority (87%) of the interviewed respondents, the density of the Baobab population in the study was reported to experience negative impacts resulting from the past drought spells, wind storms, and remarkable changes of climatic conditions. Human practices were still considered the critical threats for new regeneration, sapling development and conservation of mature trees; the greater part (94.3%) of villagers in the study area confirmed such a result. From personal observations of the authors, it was reported that concentration of large numbers of livestock in the study area has resulted in overgrazing and consequently led to destruction and finally depletion of natural resources. This would been expected because the two sites; *Elkhoway* and *Eldudia* have been historically recognized at all levels, locally, regionally and internationally as the main area of breeding and marketing of very famous high quality types of *Hamar* sheep. Many researchers (Davies, 1957; Ali, 1996; Ali & Suleiman, 1988; Alshareef, 1994) have highlighted the impacts of the overgrazing caused by the *Hamar* sheep as one of the most adversely influencing factors responsible for harmful impacts on the Baobab regeneration in West Kordofan. The problem is not only the germination process as some people think, but it is a matter of providing protection and conservation measures necessary for successful establishment and sustainability of the regeneration. The site conditions are favorable; the occurrence of sheep and goats around the area all over the year may add to fertility of the soil and thus improving its properties. On the other hand, erosion and frequent floods are considered as principal factors jeopardizing both Baobab trees and natural regenerations. As a result of heavy floods, the regeneration was eroded, and no more regeneration could be observed in the area. There were also annually up to five huge Baobabs reported to fall by wind storms or partially excavated and/or removed by brick makers or carried away by water streams (Wickens, 2008). The situation of the Baobab trees in the area is likely unfortunate, however the future might be irresistible. Such a conclusion goes in line with the future climatic predictions of Wickens and Lowe (2008).

Nowadays and from personal observations of the authors, there was no even a single seedling or sapling of Baobab seen in the study area. The husbandry and marketing activities of sheep and goats have been flourishing every day and then. The marketing process has been usually practiced under and/or around Baobab tree lots. Tens of animal herds come from far away and settle in the surrounding areas for a couple of days. No one is paying attention or thinking about the future of the Baobab tree and its sustainability for the coming generations. In this respect, the results of focus group discussion showed contradicting ideas. The Baobab trees are still unique and villagers are not interested or willing to sacrifice their ownership for any reasons. Possessing Baobab trees by heritage has still been the predominant practice. Nevertheless, no one is keen to plant a single Baobab tree or protect the area; this might be attributed on one hand to the communal use of the land after crop harvesting, and on the other hand to the policy of the Forests National Corporation, which makes the process difficult to implement). Therefore, protecting large numbers of fruits on Baobab trees during the productive season would be the focal overall objective aiming towards achieving maximum utilization of the resource.

5. Conclusion and Recommendations

The eco-situation in the study area is getting worse and the Baobab populations in West Kordofan are in urgent need for interventions aspiring at proper management and protection of the tree, as well as conservation of new regenerations.

The current study recommended development of strategic plans necessary for conservation and development of the Baobab populations in West Kordofan with special focus to the following points:

- The area should be demarcated and announced as protected area.
- Development of resource map indicating distribution, densities and age structures of the Baobab population would greatly assist in estimating present and future production potential of the area.
- The Forests National Corporation (FNC) should enforce and implement laws and regulations related to the use of land.
- Relevant institutions including the FNC as well as local community should be involved for replanting the gaps in the area by making use of the cuttings or any other propagation methods available.
- Development of effective community participation programs and involvement of local villagers and/or inhabitants in rehabilitation programs based on planting and disseminating Baobab seeds together with the seeds of other species which are usually found associated with Baobab trees.

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